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HISTORY, PURPOSES AND PROJECTS.

T H E S I S,

SUBMITTED BY

W. H. TRINKAUS.

MAY 1ST, 1915.

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Approved:

Alfred E. Phillips
Prof. Civil Engineering

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My initial step, after graduation in June, 1908, was a restudy of elementary electricity at Armour Institute, the course lasting from July to September, 1908. During October of the same year, I obtained a position as draftsman, in the Engineering Department of the City of Chicago. At the time, investigations concerning subway plans were being conducted and the location and plotting of all underground utilities was an important branch of the work. Information as to size, capacity, kind and location of these utilities, was obtained from the offices of the telephone, telegraph, gas and electric light companies. This data was compiled and plotted on sheets, each showing an area of one block, and the entire area between Twelfth, Chicago, Michigan and Halsted Streets was covered in this manner. In addition to this data, tests and observations, showing the routing and capacity of all vehicles, street cars, railroad trains, etc. entering and leaving the above area, were conducted and results tabulated. When an injunction restraining further expenditures for investigation purposes, was obtained in March, 1909, the entire force with the exception of a few heads of departments were discharged.

In May, 1909, I was engaged by The Sanitary District of Chicago, as a rodman and assigned to the engineering field force of the North Shore Channel. While employed on this work, from May 1909, to January, 1911, my duties consisted of obtaining field estimates of construction work by contractors and the Sanitary District, location of substructures for bridges, location and alignment work on the pumping station, miscellaneous field surveys and general

office work in connection with field duties. Upon the practical completion of construction work on the North Shore Channel, I was assigned to the Worth division of the Calumet-Sag Channel engineering corps. From January, 1911, to August, 1912, as head instrument man, I established preliminary center lines and established an original cross section over this division. In August, 1912, I was appointed head of the Blue Island division of the Calumet-Sag Channel and this position I retain at the present time. Since my transfer to Blue Island, all survey work, preliminary to letting of contracts (including center line alignment, original cross sections, resurveys for condemnation law suits, bridge surveyes, etc.) and all office work (including computation of estimates, sketches and plans of field work, the compiling of daily, weekly and monthly reports, etc.) has been accomplished under my supervision. The various positions occupied, while engaged by the Sanitary District, have enabled me to obtain the information necessary for a discussion of the purposes, work and plans of the Sanitary District.

Following these remarks, I shall proceed to a discussion of the subjects mentioned in my outline of thesis, sent to the College Committee.

PRELIMINARY.

Many years ago, the Great Lakes formed an arm of the ocean, but with progressive changes in the elevation of the ground, they were left in a depression. The water outlets to the ocean, were from Lake Ontario, as at present, and from Lake Michigan, southward through the Illinois and Mississippi valleys to the Gulf. This latter outlet was

the course of the ice fields during the glacial period. The southward moving glacier cut through the low hills of rock, west of Lake Michigan and wore a channel, 200' deep, 2 miles wide, and 20 miles long. When the glaciers receded northward, the channel became a natural watercourse. Swift rapids existed for a number of miles at the end of the channel in the rock, and beyond it in the softer rock, where now lies Lake Joliet, the water hollowed out a great pool. As it passed to the south, the torrent of water from Lake Michigan, broadened out into a great river, many miles wide in the low prairie land. As the present bed of this outlet can still be traced at an elevation of 7' above the present surface of Lake Michigan, it is apparent, that the level of the lake at that time, was many feet higher than it is now. During the course of time, the rocks near Chicago became slightly elevated, while the water subsided, and as a consequence, the southern outlet from the lakes gradually closed. A water shed was thus formed between the slope of the land that drained into Lake Michigan and the slope to the Illinois River. In 1674, the shore of Lake Michigan extended 11 miles inward to the site of the present town of Summit. During the last century and half, due to deposits on the shore, the lake receded to its present position and in the flat shore lands, the Chicago River formed, draining the eastern slope of the divide. During the last century, conditions were such that the sources of the Chicago and DesPlaines Rivers, (which is a tributary of the Illinois and practically the upper section of the same river) were for the greater part of the year in a common pool of water, except in dry

seasons. Land drainage and improvements due to settlement, have altered these conditions, but as a matter of fact, the barrier between, is but a trifle. The building of the Chicago Sanitary and Ship Canal was, therefore, not a reversal of natural conditions but a restoration of conditions that existed thousands of years before.

THE SANITARY DISTRICT OF CHICAGO - ORIGINAL.

The Sanitary District of Chicago is adjacent to the south end of Lake Michigan, on the west, in the County of Cook, State of Illinois. It is the urban district of Chicago and its environs, with an area of 358.1 square miles. It covers the entire water front of Cook County, some 33 miles by the shore line and naturally drained to the lake for the most part, directly and by way of the Chicago River and the Calumet River. When investigations of our water supply from Lake Michigan, showed conditions to be intolerable and unless speedily rectified, would result in a serious epidemic of typhoid and other diarrhoeal diseases, measures of relief were immediately undertaken. A Joint Committee, while utilizing investigations by Boards of Health, made researches of their own and reported the findings in the draft of a bill on February 1, 1889. The Committee advised a channel that would carry the flow of the Chicago River away from the lake and eventually discharge it into the Mississippi River. The findings took into consideration the fact, that conditions as outlined above, were ideal for a dilution process, while the state of the art of sewage purification by mechanical separation, bacterial action, oxidation and filtration was in its infancy.

In addition to this objection, the cost of adequate sewage purification on a large scale, was found to be almost prohibitive. As a consequence of the findings, the original District was constituted by authority of the General Assembly, under, "An Act to Create Sanitary Districts and Remove Obstructions in the DesPlaines and Illinois Rivers," in force, July 1, 1889.

MAIN CHANNEL EXTENSION ACT.

While built primarily for the disposal of the City's sewage by dilution and for the elimination of sewage pollution of the City's water supply, the possibilities of the channel for an inland waterway, were kept in mind from the first. The promoters of the Organic Act of 1889, contemplated the Main Channel to Lake Joliet, by reason of extensive works required through the City of Joliet, but consideration for the Illinois and Michigan Canal situation and riparian holdings below, limited the grant to the head of the Upper Basin, except the right to "correct, modify and remove obstructions in the DesPlaines and Illinois Rivers," in order to avoid damage from overflow. The water power right was limited to the interval between the end of the Main Channel and the DesPlaines River, which could be worked out, so as to cover a difference of 42.4 feet between the level of Lake Michigan and a crest of a dam, built by the State, at the south end of the Upper Basin. Tedious negotiations and litigation with the State Canal Commissioners and owners of riparian rights, prevented water power development until May, 1903, when an Act for

"Main Channel Extension to the Upper Basin and Water Power Development", was passed by the Assembly. The Main Channel Extension Act, continues the Main Channel from the Controlling Works to the head of the Upper Basin of the Illinois and Michigan Canal at Joliet, nearly 4 miles. The fall at the lock and power station site, two miles below the Controlling Works at Lockport, divides the extension into two levels.

NORTH SHORE CHANNEL.

For sometime prior to May, 1903, it became apparent, that the Districts directly north and south of the original Sanitary District, were contaminating the Chicago water supply, by disposing of their sewage into Lake Michigan. With the object of placing these districts under Sanitary District jurisdiction, the extension act of 1903,also annexed the North Shore and Calumet regions. This annexation increased the original "District" area 173.1 square miles, making a total of 358.1 square miles.

The North Shore Channel, completed November, 1910, was constructed for the purpose of further aiding to keep the water supply of the people of the District, pure and undefiled, by affording an outlet for the sewage of the large territory between the City Limits and Lake County. This territory contains the City of Evanston and several towns and villages along the North Shore. The channel extends southwesterly, from Wilmette on Lake Michigan, for about 3 miles and then practically

south for about 5 miles, to an intersection with the North Branch of the Chicago River. It has a length of about 8 miles, an average excavation of 85 cubic yards per lineal foot, and a capacity of 1000 cubic feet per second, under a 3 foot lift. The average cost of the work was a little over 20 cents per cubic yard, as against 29 cents per cubic yard, the cost of similar work on the Main Drainage Channel, due to the improvement of methods of excavation, since completion of the Main Channel in 1900.

LAWRENCE AVENUE AND 39TH STREET CONDUITS.

To take care of the sewage of the portion of the City population, lying near the lake shore, intercepting sewers, extending parallel to the shore line, have been constructed, the sewer to the north, sloping north and south to Lawrence Avenue and the sewer to the south sloping north and south to 39th Street. Near the intersection of the intercepting sewers with Lawrence Avenue and 39th Street, are located the Lawrence Avenue and the 39th Street Pumping Stations, and at these points the water is lifted for a flow to the west. The Lawrence avenue conduit, 16 feet in diameter, extends west from Lake Michigan and empties into the Chicago River, near its intersection, with the North Branch. The 39th Street conduit, 20 feet in diameter, extends west from Lake Michigan to Bubbly Creek, and in addition to conveying sewage from the main interceptor, it also aids the flushing of Bubbly Creek. While this conduit was planned to

supplement the flow in the river by some 2000 second feet, it has been operated for part of its capacity only, and to insure continuous performance to specifications, a new inlet and revised operating machinery will be necessary.

LAKE DIVERSION AT CHICAGO.

Before proceeding to a detailed account of the Calumet-Sag Channel, it is deemed advisable to submit a few facts, in connection with the controversy obtaining at present, between the Sanitary District of Chicago and the United States Government, relative to diversion of water from Lake Michigan.

During,May, 1899, previous to the opening of the Main Channel, the "District" submitted a permit to the Government, for the passage of 300000 cubic feet of water per minute through the Chicago River, or so much thereof as the River could carry without undue injury to navigation, and subject to modification, revocation and the will of Congress. The permit refers to an improvement of the Chicago River between the Lake and the Drainage Canal at Robey Street, for a flowage capacity of 300,000 cubic feet per minute,with a velocity of 1¼ miles per hour. The capacity of the river improvement had been over-estimated and after experimenting with various volumes, a "Supplemental Permit" of December, 1901, fixed the amount at 250,000 cubic feet of water through the river. No change has since been made therein, other than a permit for a temporary flow of 350,000 cubic feet per minute during the winter of 1903. This permit on its face, relates solely to the passage of

water through the Chicago River, between the lake and the Drainage Canal at Robey Street, and is conditioned, only by the capacity of said river and the protection of navigation therein. It does not neccessarily apply to flow in the closed season and to water received through adjuncts.

Since 1900, the water in the Main Channel has become greatly polluted and very offensive to sight and smell, due to the increase of population in the District and the opening of the North Shore Channel, Lawrence Avenue conduit and the 39th Street conduit. These connections have not only contributed additional sewage to the Main Channel, but the additional flow, by flushing, has increased active circulation in the South Fork and the North Branch,and as a consequence, has materially increased the burden in the Main Channel. Trade wastes in the South Fork and the North Branch, which were before largely disposed of through septic action and sedimentation, have been stirred up and brought into the Main Channel, This is the condition at the present time and is the reason why the demand for 10,000 cubic feet per second is requested of the Government.

On formal application of the Sanitary District of Chicago, to the Secretary of War, for permission to withdraw from Lake Michigan, through the Chicago River and Calumet River, not to exceed 10,000 cubic feet per second, such permission to be revocable at any time by the Secretary of War and subject to such action as the Congress of the United States may see fit to take in the premises, the prayer of the

petition was denied for the following reasons:-

1. That the diversion of 10,000 cubic feet per second from Lake Michigan, as applied for in the petition, would substantially interfere with the navigable capacity of the navigable waters in the Great Lakes and their connecting rivers.

2. That for this reason it would be inappropriate for the Secretary of War, without express Congressional sanction, to permit such a diversion, however clearly demanded by the local interests of the sanitation of Chicago.

3. That from ascertained facts, no case of local permanent necessity is evident.

4. That the provisions of the Canadian Treaty, for a settlement by a Joint Commission, of "questions or matters of difference between the United States and Canada", offer a further reason, why no administrative officer should authorize a further diversion of water, manifestly so injurious to Canada, against Canadian protest.

As a rebuttal to the reasons for refusal of the permit by the Secretary of War, the Sanitary District submits the following arguments:- (condansed as largely as possible).

1. That the Chicago Drainage Canal and the Illinois and Michigan Canal are established on the basis of natural streams or outlets, by proper and sufficient authority and the disposal of sewage in such channels is on the same footing as in natural streams.

2. The Secretary of War is delegated by Congress, with certain powers respecting the conservation of the navigable waters of the United States, and this legislation does not authorize an interference with the diversion of waters, by way of the Chicago Drainage Canal, for various reasons, the powerful one being , that the rights of States are superior to those of material and artificial persons, to whom the legislation particularly applies.

3. No material effects result from the Chicago diversion.

(a) The degree of effect, is an inference from "subtle expert analysis" and not capable of proof by direct observation.

(b) The effect is a part of, and contributory to much greater changes that have not been thought worthy of correction.

(c) No competent official observations or deductions therefrom, were made until after the opening of the canal and such observations and deductions are still in progress.

(d) The interested public was fully advised respecting the probabilities, prior to and during the construction of the Chicago Drainage Canal and no protest was made.

(e) A margin of depth beneath the vessel, several times the alleged defect, is recognized as sound practice and is dictated by prudence on account of unforeseen fluctuations.

(f) Channel and harbor deepening, during and since the construction of the drainage canal, are still in progress and greater depths, already predicated by the Davis lock, many times exceed the alleged effect.

4. The benefits exceed the damages.

(a) The damages as officially estimated, are small in comparison to benefits, and such estimates are excessive.

5. Adequate remedies are feasible, varying with the locality and purpose.

6. The Canadian grievance, does not differ in character from that of the United States but is normal above Niagara. Her chief population and commerce pertain to Lake Ontario and the St. Lawrence, where the effects are less and the commerce small in comparison to the upper lakes. Remedies are easily applied. Treaties give Canada no redress.

Thus the arguments stand and at the present time, new information and statistics are being prepared for submission to the Government with a hope of a change in decision.

CALUMET-SAG CHANNEL.

Since the starting of the Government suit, the Engineering Department of the Calumet-Sag Channel, has aimed to develop some project, which would adequately take care of the Calumet district, whether or not the Sanitary District is allowed to take 10,000 cubic feet per second from the lake. Under the diversion of this amount of water from Lake Michigan, three projects were developed. The project finally decided upon, consists of a canal through the Sag Valley, capable of carrying 2,000 cubic feet per second, with intercepting sewers conveying the sewage of the Sag district to the east, to the beginning of the canal. The canal begins just east of Blue Island, where the sewage from the interceptor will be discharged west of the controlling works. Under this project

7,000 cubic feet per second will be brought through the Chicago River, 1,000 cubic feet per second through the 39th Street conduit and 2,000 cubic feet per second through the Calumet-Sag Channel, making a total of 10,000 cubic feet per second. On account of the large floods of the Calumet region in times of freshets, it is not practicable to divert the entire flood waters of the District to the main canal at Sag, as this amount of water discharging into the canal at this place,would crowd the Chicago River waters into the lake and would much exaggerate the flooding or overflow conditions of the Illinois Valley. With a 2,000 foot canal, there would be only about 25 days during the year,when the Calumet River would discharge into the lake, and only 8 days, when it would be stagnant. Whether the suit with the Government is won or lost, this project with some additional purification features, will suffice.

PRELIMINARY CONSTRUCTION WORK.

After deciding upon the project, immediate steps were taken to secure the necessary right of way. The first construction work, done in connection with the Calumet-Sag Channel, was the deepening of the Calumet Feeder from the Illinois and Michigan Canal, for a distance of 3½ miles east. The reopening of this natural drainage ditch,has drained the western portion of this territory through which the channel is to be excavated, thus facilitating the work of construction. This improvement was performed by means of a floating Marion dredge, equipped with a 40-ft. boom and a 1¼ yard dipper. To drain the middle of the cut in like manner, the Sanitary District excavated a drainage ditch, extending from Piper's Road, the west end of Section #8, to a point near the west

City Limits of Blue Island. At this point, the ditch empties into Stony Creek, the natural drainage stream for the east end, and is then carried to the Little Calumet River. An examination of print I will give a comprehensive idea of the location of the Calumet-Sag Channel and surroundings. This work was preliminary to the letting of contracts for the construction of the channel through the middle portion. For the purpose of draining the east end of the work and facilitating construction, a diversion of the waters of Stony Creek was necessary and this was accomplished by means of a ditch, 50 feet on the bottom, with 1 on 1 side slopes, beginning at the C. R. I. & P. bridge over Stony Creek and extending southeast, to an intersection with the Little Calumet River. Excavation was accomplished by means of a 70-ton Vulcan shovel, with 35-ft. boom and a 2½ yard bucket.

MATERIAL AND CROSS SECTION.

The construction of the east and west ends of the canal, is facilitated by the fact that the ground is fairly high and dry, but the middle portion lies in a swamp, some 5½ miles long and varying in width from 1/4 to 1/2 mile. This fact renders the excavation of this portion somewhat more difficult, presenting the difficulty of handling a large amount of surface water at practically all times, while the work is under way.

The material to be removed has been classified under the two general heads of "glacial drift" and "solid rock", and unit prices are paid on this basis. "Glacial drift" is described, as comprising "all material that overlies the solid, stratified limestone rock in its original bed, and "solid rock" comprises "all stratified limestone found in its original bed."

While these are the general heads, the material encountered at the east and west ends of the canal, differs widely from that found in the portion through the swamps. On the high ground, 1 foot to 2 feet of black dirt is followed by sandy clay and gravel, from 3 to 6 feet in depth. Below this is encountered hard white clay, gravel, boulders and conglomerate, a material almost as hard as cemented gravel and boulders. The average rock cut at the west end varies from 15 feet to 25 feet, while at the east end, the cut is somewhat less. The average total depth of excavation is about 35 feet. Through the swampy portion, extensive peat beds and decayed vegetable matter are encountered, extending from the surface to a depth of from 3 feet to 15 feet. Below this, a layer of silty clay, of very unstable character, varying from 3 feet to 8 feet in depth is found, and underneath this, a stratum of hard clay, cemented gravel and boulders, generally overlies the solid rock. Through the swamp, the rock cutting varies from about 15 feet to nothing, and the average total depth of excavation is about 35 feet.

The radical difference between the materials encountered, through the high and low portions of the Right of Way, necessitates a change of cross section. When the rock cutting is less than 15 feet, an "earth section" is used, and where the rock cutting is greater than 15 feet, a "rock section" is used. Due to changes in stability of the materials encountered, the right of way of the channel varies from 200 feet to 1200 feet each side of the center line, the wider portion being required where the material is softest. To provide for future enlargement of the channel, without the rehandling of spoil, the south berm has been made larger than the north berm. Both earth and rock sections have been designed to carry 2,000 cubic feet of water

per second, with an approximate depth of 20 feet and an available fall of 3 feet, from Lake Michigan to the Main Drainage Canal at Sag. In addition to the large drainage ditches built by the Sanitary District, collateral ditches, to intercept and carry off surface drainage during construction, have been designed. These ditches are built by the contractors at unit prices and extend along the edges of the right of way. They are connected with the channel at frequent intervals by cross ditches and concrete outfalls are provided at their outlets.

PRELIMINARY AND CONSTRUCTION SURVEY WORK.

Preliminary to letting of contracts and beginning of construction, considerable field work is necessary. The center line of the channel, with the necessary offset lines, are first established. Small pine stakes, with a cupped tack, are placed at the 100 ft. points and oak hubs with a cupped tack are set every 500 feet and at all changes in alignment. The offset lines are so established, as to extend along both berms and be available when excavation is started and the center line destroyed. All important points on the center line and offset lines are referenced when possible, to points beyond the spoil limits, to provide for re-establishment in case of slides or upheavals. After the establishment of center line and offset lines, the elevations of the original ground were obtained. Cross sections were taken every 25 feet and the sections extended to an average of 250 feet each side of the center line. The elevations along cross sections are taken every 20 feet and at all breaks in the ground. 24 bridges will cross the channel and bridge

surveys, showing plusses and angles at the intersection of center line of channel and the center line of roads, detailed cross sections at right angles to the center line and at right angles to the roads, showing ditches, drains, etc., and the location of all private and public utilities, were made. Miscellaneous information as to location of property lines, for use in condemnation proceedings, the location, alignment and elevation of public roads in the vicinity, measurement of existing bridges, culverts, drains, etc. was obtained, when demanded. After plans and specifications were obtained from the Main Office, line, slope, and grade stakes were set for the collateral ditches,and slope stakes established for the main cut. These slope stakes consist of 3" iron pipes,6 to 8 feet in length and driven 4 to 6 feet in the ground. They are practically permanent and only need resetting when torn loose by the drag lines. Upon the starting of construction work, a field force is continually used in setting line and grade stakes, laying out diversions, flumes, culverts, etc., and obtaining field information necessary for monthly estimates.

OFFICE WORK.

Office work consists principally of the preparation of all daily, weekly and monthly reports, preparation of sheets and drawings of field measurements and surveys, and reduction and computation of field notes, for the purpose of preparing the monthly estimates for contractors. A complete record is kept of all men and material employed and used on the various sections and a proper distribution made of the same. (For sample of monthly material report see print II.) This

information, upon reduction, enables the District to keep a complete check upon operations of contractors.

Monthly estimates are obtained by the following process. The total yardage between the original surface and horizontal plane, below the bottom grade of the channel, is obtained between any stations, as for example between Station 620+00 and Station 630+00. The elevation of the ground, after monthly excavation, is obtained between the two limits and the total yardage between the surface and the base plane is computed. The difference between the two computations is the amount excavated. This system is simple and eliminates interpolation and irregular ordinates.

CONSTRUCTION WORK.

The Calumet-Sag Channel, extending from station 0+00 to station 857+10.41, is divided into 14 contract sections, and at the present time sections 1 to 12 are under construction. Only 3 of these sections, 10, 11, and 12, are under my supervision, while one, section #9, is practically (due to inspection and force account work) under my care. Construction work on sections 1 to 8, will only be considered in general, while a more detailed account will be attempted for sections 10, 11 and 12. An examination of print III will give information, concerning the contracts on the different sections, amount of unit quantities, prices, etc.

CONTRACT SECTION #1.

Rock Section.

Work of digging the collateral ditches on this section, started during December, 1914, was accomplished by means of a small Bucyrus shovel and outcropping of rock, necessitated blasting

of most of this material. At the present time, excavation of glacial drift from the east half of the section, is performed by means of a #76 Marion shovel, with special boom and dipper stick, and a 2½ yard Marion bucket. The material is emptied into 3½ yard cars and conveyed to the spoil area by means of dinkey engines. The contemplated scheme of excavation is as follows:- The remaining glacial drift is to be removed by two 175-B steam drag lines, weight 230 tons each, length of boom 125 feet, working on each berm. After removal of glacial drift, the rock is blasted and moved to spoil area by the use of 8 yard skips. These skips, loaded by the steam shovel, working in the cut, are raised and swung by the drag lines. Three new Sullivan Duplex channeling machines, the largest type made, with a double chopping engine, are to be installed for rock channel, and new Sullivan Improved Tripod Drills with a 1½" hollow steel, will drill the rock. A 7,000 ft. 3" pipe line on the north berm, with taps every 100 feet, is a distinct improvement over general methods.

CONTRACT SECTION #2.

Rock Section.

With the exception of some rock excavation at the west end and the building of concrete walls on each side of the channel, work on this section is practically completed. (See picture #1.) The excavation of glacial drift in the channel, was accomplished with a Bucyrus drag line excavator, moving along the berms. The machine is equipped with an 85 ft. boom and Bucyrus and Page 2½ yard buckets. After removal of glacial drift, the blasted rock was loaded on 4 yard dump cars, by means of a #76 - 70 ton Bucyrus steam shovel, with special boom and dipper stick, and

hauled to the spoil area by small locomotives, in 11 car trains. The cutting of the vertical rock faces was performed by means of Ingersoll-Rand steam channelers, and drilling was accomplished by means of Ingersoll-Rand steam drills. Jack-hammer steam drills, for use in drilling holes from 1 foot to 3 ft. in depth, are used as shown. (Picture #2).

CONTRACT SECTION #3.

Rock and Earth Sections.

Excavation of glacial drift and the first lift of rock is completed on this section. Excavation of glacial drift was accomplished by means of a style C, Lidgerwood steam drag line, weight 160 ton, length of boom 70 feet and 1½ yard buckets, and a Lidgerwood drag line, weight 75 ton, length of boom 70 ft. and 2½ yard bucket. Removal of rock was performed by means of skips fastened to the drag line boom and loaded by means of a Marion shovel, weight 90 tons, length of boom 26½ ft., length of dipper stick 26½ ft., and a 2½ yard bucket. (Picture #3 shows the thickness of the layers of rock in places).

CONTRACT SECTION #4.

Earth Section.

This section has presented many difficulties, due to the soft material encountered, which has caused a number of serious slides. Excavation of glacial drift, was performed by a Marion self-propelling steam drag line excavator, with a 100 ft. boom, 3½ and 6 yard Marion buckets and hydraulic jacks under each corner. On account of the sliding into the channel of portions of the berm and spoil area, steam shovels were used in the cut and earth and rock loaded into

cars and hauled to the spoil area. At present, an agreement has been made, whereby the contractor on section #3, will haul rock and hard material from section #3, by means of cars and dinkeys and deposit it between the side slopes and the theoretical. (Picture #4 gives an idea of the irregular slope of the rock encountered at times.)

CONTRACT SECTION #5.

Earth Section.

The material on Section #5 changes near the middle of the section, from hard clay and stone to soft clay and peat. Work of excavating the hard glacial drift and rock at the west end, was accomplished be means of 2 electrically operated, Lidgerwood drag lines. They weigh 145 tons each, have 100 ft. booms and use 2½ yard Page buckets. Drilling was accomplished by means of 3 Ingersoll-Rand wagon drills and an old Buckeye well drilling machine. For the excavation of the soft material on the east end of the section, a 12" electrically operated hydraulic dredge, with a 12" Morris pump, having a cutter on the end of the suction pipe to allow material to enter, was designed, and is now in use. (Picture #5). The soft material will not maintain the theoretical slope and after removal of all such, a drag line will be placed in the cut and the space behind the theoretical slope, backfilled with hard material.

CONTRACT SECTION #6.

Earth Section.

The material on Section #6 changes from the soft to the hard and back again, and as a consequence, the same methods of excavation used on section #5, were used on section #6, the portion

of the section through the hard material, is practically completed and rip-rap paving on this section is in splendid condition. (Picture #6). The west end of section #6 will be excavated in the same manner as sections #7 and 8.

CONTRACT SECTION #7 AND #8.

Earth sections.

These sections extend through the swamp region and work of excavation can only be accomplished by means of hydraulic dredges. The dredge in use has an 18" intake, with pumps operated by electricity. A 2300 volt submarine cable transmits electricity from the high line to the machine. After removal of soft material from the cut, by dredge and pipe line, a 200 ton electric shovel with a 72-ft boom, a 35-ft. dipper stick and a 3½ yard Marion bucket, will load material into cars for transportation to spoil area. These cars will have a capacity of 12 yards and will be driven by a motor on each end, receiving electricity from a third rail.

CONTRACT SECTION #9.

Earth Section.

A different scheme for the removal of dirt from the cut to the spoil area, appears on section #9, in the form of an incline and tipple. (Picture #7). A Marion steam shovel, weight 175 tons, 75-ft. boom, 50 ft. dipper stick and 3½ yard bucket, removes the material from the channel and deposits it in 7 yard cars at the foot of the incline. (pictures #8 and 9). The incline is about 180 feet long and the highest point is 55 feet above the ground surface. It rests on small flat cars, which move on two standard gauge

tracks, 75 feet apart and running parallel to the center line of the channel. On account of springs encountered in the cut, the material excavated is very soft, and when spoiled, flows in all directions. This condition is serious, as the spoil, pressing against the inner support, tends to push it toward the channel, (Picture #10), and as a consequence, overturning and twisting stresses have been set up in the members of the incline. The dumping of the material from a height of 55 feet onto the soft ground, has caused in many instances, upheaval of the ground, adjacent to and even underneath the tipple and as a consequence, additional strains are created, (Picture #11). An ingenious device has been designed to overcome the changes in alignment of track caused by spoil pressure. The tracks parallel to the center line are laid on greased rails, at right angles to the main track and when a pressure is created and the track moved, the entire support is jacked along the greased rail back to the original position. Oftentimes, the spoil presses against the rails in front of the flat cars, bending them and necessitating the removal of the spoil and a straightening of the rail. If an incline and tipple could be designed, whereby one dumping point could be made, midway of the incline, this difficulty could be corrected, for hard material from the top of the cut could be dumped from this point, thus creating a levee that would retain the softer material spoiled from the top. Laying of rip-rap has been completed for a short distance (Pictures #12 and 13).

CONTRACT SECTION #10.

Special Earth Section (See Print 4).

Glacial drift on this section, was removed practically to solid rock, by means of two Shnable & Quinn drag lines, weight 170 tons, length of boom 120 feet and 3½ yard Shnable & Quinn buckets. (Picture #14). The counterweight on the machines, consists of a 20 ton engine, 10 ton boiler, 5 tons of coal, 500# water tank and 57,000 lbs. of pig iron. These drag lines are slightly different from the other drag lines in use, because of the bucket used and the method of applying the force. This bucket dumps from the front instead of the rear and as a consequence, is able to deposit material further away from the cut. This bucket is claimed by the owners, to give a greater reach, can always enter the cut in a digging position, can be hoisted close to the sheave and never becomes barrel shaped or turns turtle. The boilers used are of the locomotive fire box type with 125 H.P.

The drills used are Ingersoll-Rand wagon drills, and are mounted on a four wheel platform. The platform carries a boiler that furnishes water to the drills, steam pressure for cleaning holes, power to the engine that raises and lowers drills, and power to the traction engine that moves the wagon. The drill is mounted on a set of leads, similar to the leads of a pile driver, (Picture #15). The rock, which averages about 27 ft. in depth, is drilled and shot in two lifts, the first of 13 feet and the second of 14 feet. The holes are drilled in rows, 7 feet apart and staggered 7 feet. 40% DuPont's non-freezing dynamite is used, the amount

used running as high as 3500 pounds per shot.

This section is a special earth section, with a 50 ft. bottom, with one on one side slopes to -4.0 and one on two side slopes between -4.0 and the original surface. The rock slope may be excavated in steps but no points of rock shall project within the theoretical lines. Side slopes are to be rip-rapped above solid rock and to -15.0 (for protection of boats,) if so directed. The rip-rap, of average thickness of 1 ft., shall be prepared by laying a bed of stones of varying sizes, so placed, that no large voids shall occur therein, upon which bed,a layer of "one man" stone, shall be hand placed, with all cracks and crevices filled with smaller stones and spalls. The surface shall be finished to a reasonably smooth plane. In addition to channel and ditch excavation, the contractor has required to construct the substructure of a steel bridge across the channel, the substructure consisting of abutments, piers and wing walls, resting on the solid rock.

CONTRACT SECTION #11.

Special Earth Section.

Section #11 is another entire earth section. After removal of the black dirt on the surface, by means of New Era Graders and teams, the remaining glacial drift in the channel was excavated by means of a Bucyrus electric drag line, #775-B, The drag line weighs 240 tons, has a 125 ft. boom, a 3½ yard Bucyrus bucket and needs a 70 ton ballast. The base of the cabin is about 15 feet above the ground, and moves on a built-up section of channels and I beams, extending parallel to the berm. (Pictures #16 and 17). The electricity is furnished by the Public Service Company of Northern Illinois, whose line touches the east line of this section. A sub-station

has been erected near the east end, where the 12,000 volts from the main line is stepped down to 2300. From the sub-station, the wires extend between poles, running along the entire south berm. Transverse lines from these pole wires, carry the electricity to a set of transformers,erected on a wagon, which follows about 200 feet behind the drag line. At the wagon, the current is stepped down to 440 volts and this transferred to the drag line. The electrical equipment eliminates coal haul and pipe lines,and while the cost of installation of electric plant is high, the salvage is always considerable. Pumping of water in the channel is accomplished by means of an American Well Works centrifugal pump, erected on afloating barge. The pump has two 35 H.P. induction motors, working two pumps into one discharge. Against a 50 ft. head each pump is guaranteed to deliver 2000 gallons per minute.

At the present time, a Bucyrus 70-C electric shovel, weighing 70 tons is being placed in the cut at the east end, and upon the completion of connections, will excavate the blasted rock. The rock will be loaded into 9 yard steel skips, attached to the boom of the electric drag line and then transferred to the spoil area.

On account of softer material encountered near the middle of the section, the "earth section" changes from the special one on one and one on two combination, to a straight slope from a 36 ft. bottom to the original. The rip-rap section at this point also changes, necessitating a layer of rip-rap, one foot thick at the surface and about 3 feet thick at the rock.

CONTRACT SECTION #12.

Earth Section and Rock Section.

Section #12 is a combination earth and rock section, the rock section, commencing at a point about 1/3 mile from the west end. Excavation of glacial drift was accomplished by means of an 80 ton Marion drag line with a 100 ft. boom and a 3½ yard Page bucket. At the present time, a Marion steam shovel is being built weighing about 175 tons. This shovel, placed in the cut, will load the blasted rock into cars, which by means of an incline and tipple, will be dumped on the spoil area. From station 708+70 to 712+55, the "earth section" changes to a "rock section" and this section is then maintained to the end of the channel near Fay's Point. Print 5 shows an average rock section and details. The concrete wall on each side, resting on the solid rock, is made of a 1 : 3 : 5 mixture of cement, sand and crushed stone, with pieces of "one man" rock imbedded in the concrete, in such a manner, that they will be entirely surrounded by at least 3" of concrete with no stone within 6" of any form. To provide for accidents, "life" ladders are to be placed in the faces of the retaining walls, at intervals of about 500 feet throughout the entire length of both retaining walls, and two continuous horizontal grooves are to be formed in the face of the walls for their entire length.

SECTIONS #13 AND #14.

Rock Sections.

Plans and specifications for sections #13 and #14 are being prepared at the present time and construction work on these sections, will in all probability, be started shortly. The average "rock section" will extend from the west end of section #13 to the middle of section #14, where a change to a widened section, extending to the controlling works, will be resorted to. The controlling works, built near the east end of section #14 and about a thousand feet west of the intersection of the center line of the Calumet-Sag Channel and the center line of the Little Calumet River, will regulate the flow of water from the Little Calumet River into the Calumet-Sag Channel, by means of two pair of sector gates, swinging on vertical hinges. Opening and closing the gates will allow passage of boats, as well as regulating the water flow. Sections #13 and #14 present many difficulties in the way of crossings, railways, streets, sewers, etc. and the care which must be observed in blasting. Disposal of spoil in the right of way areas, will be restricted by specifications as to height of spoil, and by roadways and grades in the vicinity of the controlling works.

CONCLUSION.

Work on the Calumet-Sag Channel is to be completed by November 1st, 1917 and the beginning of the new year should witness the completion of another big Sanitary District project.

Respectfully submitted,

WHT:H

W. H. Trinkaus

PLATE 1

MAP
OF
CALUMET SAG CHANNEL
from the
ILLINOIS AND MICHIGAN CANAL
to the
N.S. & Sec 32 37 N. E of 3rd P.M.

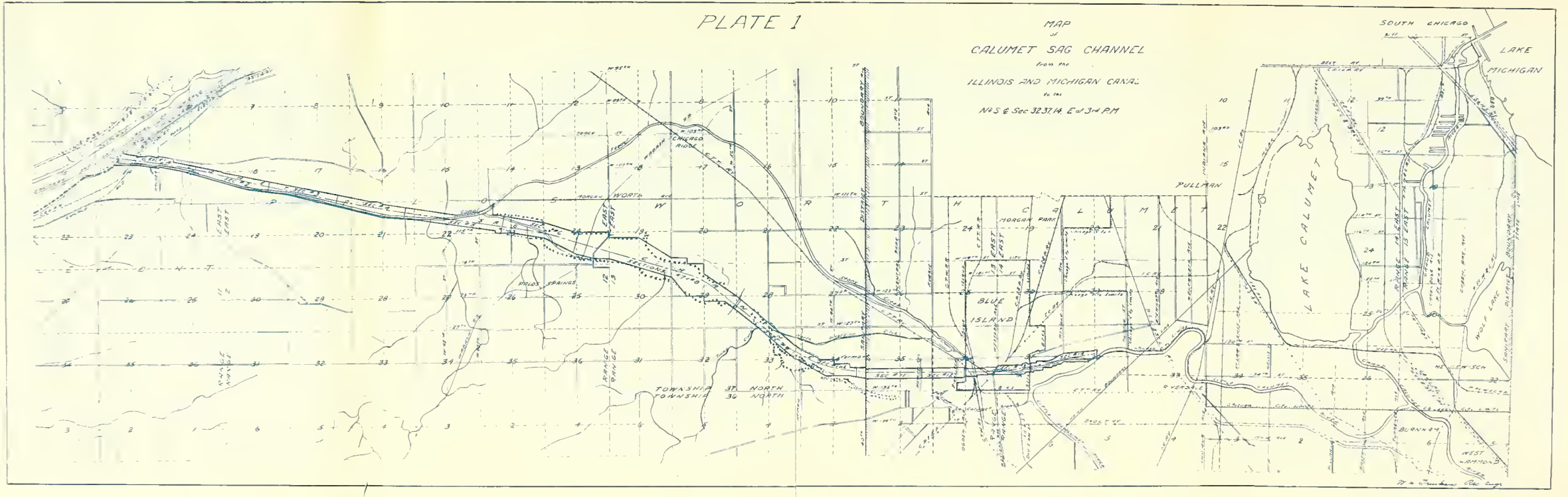


PLATE #II

THE SANITARY DISTRICT OF CHICAGO
CALUMET - SAG - CHANNEL
DATA ON WORK UNDER CONTRACT

SECTION				CONTRACT				EXCAVATION OF GLACIAL DRIFT		EXCAVATION OF SOLID ROCK		RIP - RAP SLOPES		CHANNELING		ROADWAY CONSTRUCT		CONCRETE CONSTRUCTION								CONCRETE CYLINDERS		REINFORCING METAL		ERECTION OF STEEL BRIDGES		TOTAL VALUE OF CONTRACT
																		Retaining Wall		No.1 Concrete		No.2 Concrete										
No	Station To Station	Length Feet	Character	Contractor Name	Contractor Address	Date of contract	Required Date of Completion	Quantity Cubic Yards	Price $	Quantity Cubic Yards	Price $	Quantity Sq Yds	Price $	Quantity Sq Ft.	Price $	Quantity Lin. Ft.	Price $	Cu Yds	$	Cu Yds	$	Cu Yds	$			Quan. Cu Ft	Price $	Quan Lbs	Price $	Bridge	Lump Sum	Based on Estimated Quantities
1	3+00 To 54+38.4	5138.4	Rock Section	James C Heyworth	Chicago, Ill.	Sept 24, 1914	Nov 1 1917	320,000	030	328,000	070	500	200	270,000	033	570	200			550	600	28,500	480					80,000	005	Archer Road	$ 4000	$ 564 940 00
2	54+38.4 To 137+32	8293.6	Rock Section 60' wide - Vertical sides - 1 on 2 1 on 1/2 above rock - Original rubble wall changed to concrete wall	Winston Bros. Co	Minneapolis Minn 801 Globe bldg	Nov 2, 1911	Oct 1 1915	221,000	022	351,000	065			313,000	020			6,400	7.00													$ 384,170 00
3	137+32 To 91+10.55	5339.73	Rock Section from 87+12.82 To 185+00 Change Section - 185-186 Earth Section from 186+20 To 191+10.55	S R H Robinson and Sons - Contractors Co	St Louis, Mo Chemical Bldg	Feb 23, 1912 Also supplemental agreement	Oct 1 1915	335,000	029	220,000	069	5,000	100	182,300	025			13,400	495													$ 345,855 00 changed
4	191+10.55 To 244+57.80	5377.25	Earth Section 36' bottom 1 on 2 side slopes	Forschner & Sexton Assigned to Thos J Forschner Supplemental Agreement	Mt Vernon, N.Y.	Sept 2, 1911 Assigned Jan 22, 1912 Supplemental Jan 23, 1913	Aug 1, 1915 Extended to July 1, 1916	780,000 422,195 379,143	025 025 040	121,000	077	37,000	050																			$ 306,670 00 $ 387,106 00
5	244+57.80 To 326+15.25	8127.45	Earth Section Rip-Rap to Elev +10 36' bottom - 1 on 2 side slopes	Green & Sons Co	Chicago, Ill. 563 Mc Cormick Bldg	June 22, 1912	Oct 1, 1915	1,070,000	024	141,000	070	69,000	100			4,800	100			375	1000	600	700			900	060	30,000	004	Mc Laughry W 82nd St	$ 3000 $ 3000	$ 444,990.00
6	326+15.25 To 380+00	5384.75	Earth Section - 36' bottom - side slopes on 2 from Sta 326+18 to Sta 355 and 1 on 3 above - 40 355 to 380	Green & Sons Co	Chicago Ill	April 10, 1913	Nov 1, 1916	675,000	0425	135,000	0815	75,000	1.00																			$ 471,900 00
7 8	380+00 To 525+00	14500.02	Earth Section 36' bottom, side slopes 1 on 2 below -40 and 1 on 3 above -40	Green & Sons Co	Chicago, Ill	June 26, 1913	Nov 1, 1917	2,350,000	0425	15,000	190					3,075	225			1200	1000							19,000	006	Worth Road Piper Road	$ 7230 $ 10,500	$ 1,065,038 75
9	5.5+00 To 56.3+00	5500.00	Earth Section 36 bottom - 1 on 2 side slopes - Spoil on one side	Byrne Bros Dredging and Engineering Co	Chicago Ill	Sept 25, 1913	Nov 1, 1917	875,000	02875	50,000	125	70,000	075			1,750	250			1100	800	1350	750					90,000	006			$ 395,262 50
10	580+00 To 646+91.85	6691.85	Special earth section - 50' bottom side slopes 1 on 1 down -40 and 1 on 2 above -40	Shnable & Quinn	Chicago, Ill. 30 W La Salle St	April 3 1913	Nov 1, 1916	670,000	0326	300,000	069	72,000	077			2,500	120			800	844							20,000	004	48th Ave	$ 4000	$ 495,412.00
1	646+91.85 To 698+00	5108.15	Special earth section 50 bottom from 646 to 685 to 674+06 Payment for earth section from 675-66 To 698+00	James C Heyworth	Chicago Ill	March 12, 1914	Nov 1 1917	750,000	0292	85,000	065	70,000	065																			$ 319,750.00
2	698+00 To 739+55.6	4155.6	Payment for earth section to Keeler Ave Sta 721+31 Rock section east of Keeler	Byrne Bros Dredging and Engineering Co	Chicago, Ill	May 21, 1914	Nov 1, 1917	485,000	0255	125,000	070	25,000	070	100,000	0285	2100	200			950	1175	10,000	575			5,500	050	55,000	003	Homan Ave Kedzie Ave Francisco Ave	$ 4950 $ 1,650 $ 650	$ 342 687.50
13	739+56 To 796+00	5744.4+																													
14	796+00 To 857.104	6310.4																													

H. O. Trueblood

THE SANITARY DISTRICT OF CHICAGO
CALUMET SAG CHANNEL

PLATE # III

CONTRACTORS
Shnable & Quinn

MONTHLY MATERIAL REPORT - SECT. #10 October 1914

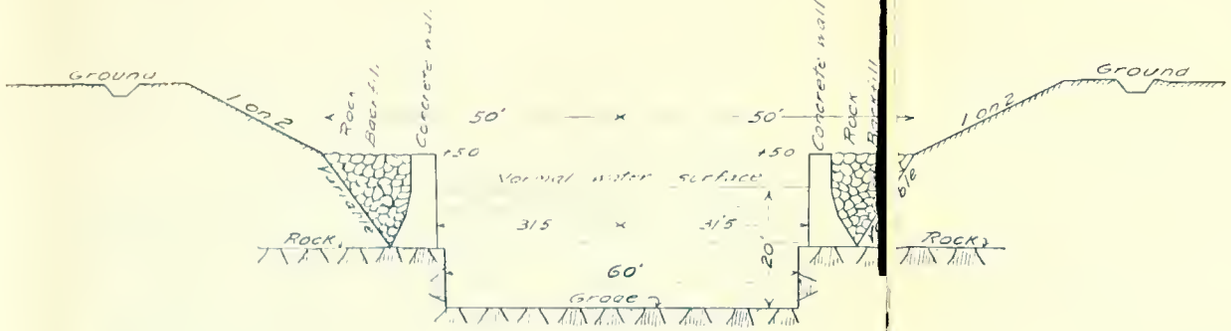
Material	Unit	Price	Amount on hand beginning of month	Received during month	Total to be accounted for	AMOUNT USED DURING MONTH: Drag Line #1	Drag Line #2	Drag Line #3	Tipple	Steam shovel	Drilling	Blasting	Channel'ing	Shop	Gen'l Acct.	Auto		Camps	Pumping: Channel	Pumping: Service	Amount on hand end of month
#1 Yellow pine	B.M.	28.00	6762	1200	7962										28						7934
#2 Yellow pine	"	24.00	493	368	861										861						0
White Oak	"	30.00	240	0	240																240
Maple Rollers	Lbs		10	0	10																10
Blacksmith Coal	"	550	0	5800	5800										1600						4200
Chestnut "	Ton	750	350	4800	5150										1250						3900
Pocahontas "	"	2.20	260	204	464	40		90			85				10				25		164
Cylinder Oil	Gal	30½	177	161	338	100		100			60								5	5	68
Auto "	"		30	0	30															3	27
Black "	"		82	54	136	20		20													54
Linseed "	"		3½	0	3½																3½
Kerosene	"	10½	192	0	192	15		15			20				60					8	74
Gasoline	"	12	109	168	277										22					100	55
Pinion Grease	lbs	3½	143	0	143	65		60													18
Cup #2 "	"	3½	15	0	15																15
" #3 "	"	3	32	0	32	16		16													0
" #4 "	"	2¾	50	0	50	15		10													25
Alcohol	gal		2	0	2																2
Paint - black	"	35	5	0	5																5
" - mineral	"	35	3	0	3										3						0
" - red	"	32	3	0	3																3
Boiler Compound	lbs		159	0	159	40		40							50				10		19
Dynamite	"	10½	2900	26500	26790							19165									7935
Exploders			952	2400	3352							2677									675
Ice	lbs	.15	0	7300	7300										7300						0
Hay (Timothy)	"	1650	18000	0	18000										1200						16,800
Oats	bus	.55	25	50	75										50						25
Corn	"	.60	0	10	10										5						5

Remarks:- Repair parts received - 4 pieces 1⅛" cable - 285' - 1 gear for wagon drill #1, 16 bucket teeth, 2 boxes wagon drill repair parts, 10 pieces 2" octogon drill steel, 20' long, 4 kegs rivets, 5½", 6", 6½", 7", 1 stuffing box for wagon drill, 6 pieces 1½" x 16', 6 pieces ⅝" x 16' round iron, 2-14" & 1-12" sheaves, 1 steam hose, 1½" x 20', 4 pieces channel iron, 3/16" x 2" - 16' long, 1 brace & set of bits, 1 set pod castings, 1 set of grate bars for drill boiler, ⅝-⅜" bits, 1-8" x 36" nipple for centrifugal pump, 4 pieces, ¾" x 3" - 16' flat iron, 200 - ⅝" x 6" rivets, 12 shackles for drag lines, 1 box bolts for rock drills, 1 shaft for wagon, auto repairs $128.00, 4 pieces - 5' channel iron, ⅜" boiler stay bolt and tap, ½-⅝" copper rods, 6' long, 4 bucket eyes, 1 keg 1¼" square nuts,
Plant received - 1-5 HP gas engine and pump, 500 # colored waste,
Repair parts used - 285' - 1⅛" cable on drag-line #3.

Respectfully submitted,
W. B. Trumbauer

PLATE # IV

ROCK SECTION
TYPICAL SECTION OF CHANNEL



FRONT ELEVATION

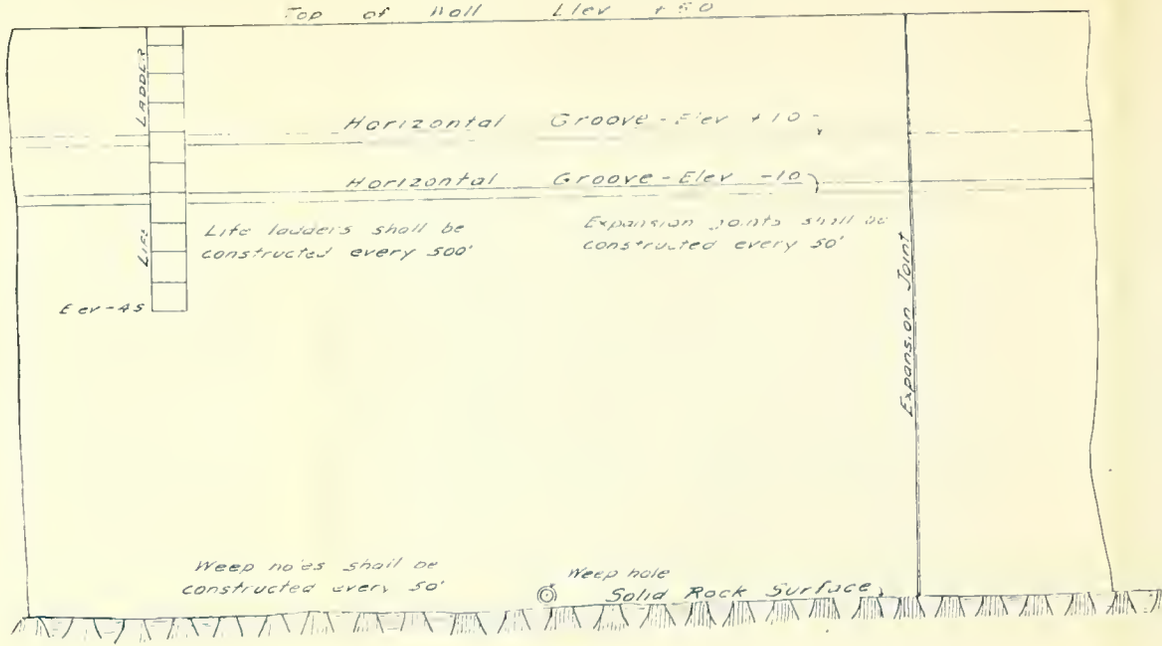
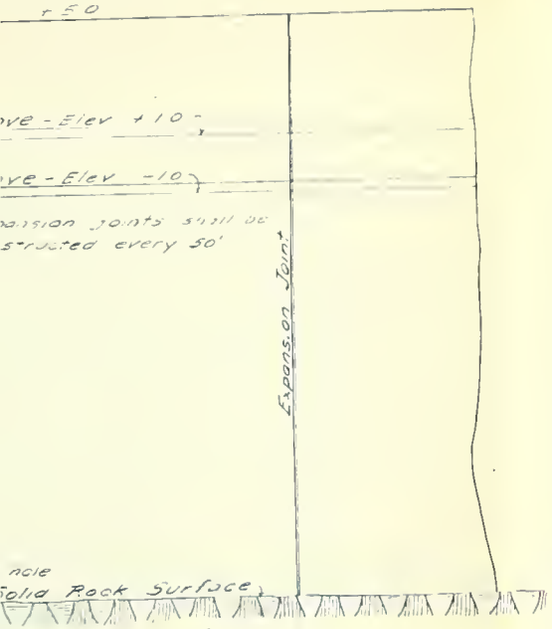
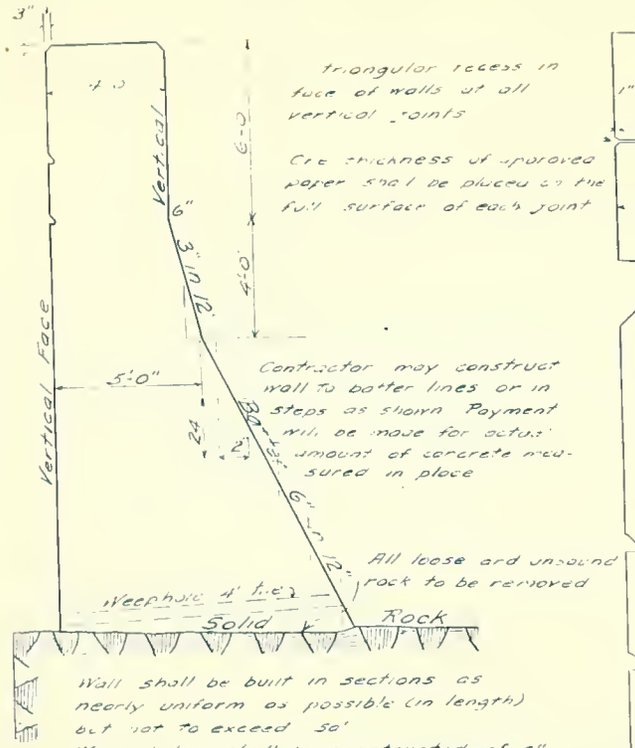

Top of Wall Elev +50
Ladder
Horizontal Groove - Elev +10
Horizontal Groove - Elev -10
Life ladders shall be constructed every 500'
Expansion joints shall be constructed every 50'
Elev -45
Expansion Joint
Weep holes shall be constructed every 50'
Weep hole
Solid Rock Surface

PLATE # IV

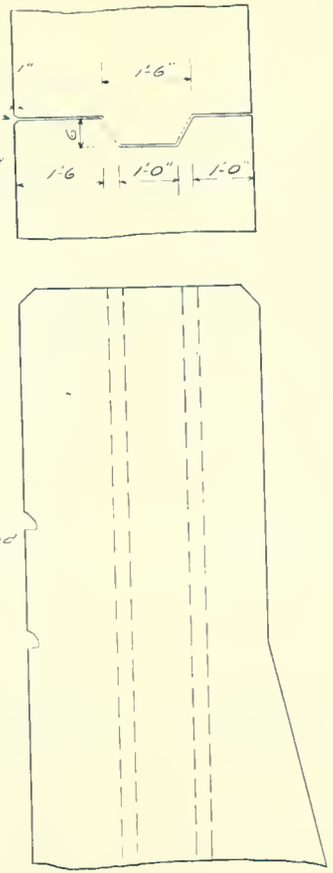
EVATION



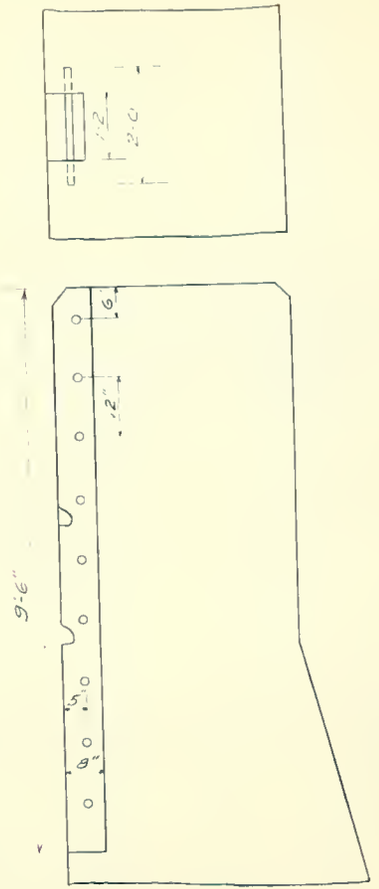
SECTION


3"
4'-0"
Vertical
6"
3" in 12"
Vertical Face
5'-0"
2'
Batter
6" in 12"
Weephole 4" tile
Solid Rock
triangular recess in face of walls at all vertical joints
One thickness of uproved paper shall be placed on the full surface of each joint
Contractor may construct wall to batter lines or in steps as shown Payment will be made for actual amount of concrete measured in place
All loose and unsound rock to be removed
Wall shall be built in sections as nearly uniform as possible (in length) but not to exceed 50'
Weep holes shall be constructed of 4" bell end vitrified tile Rear entrance to tile shall be well protected by crushed stone

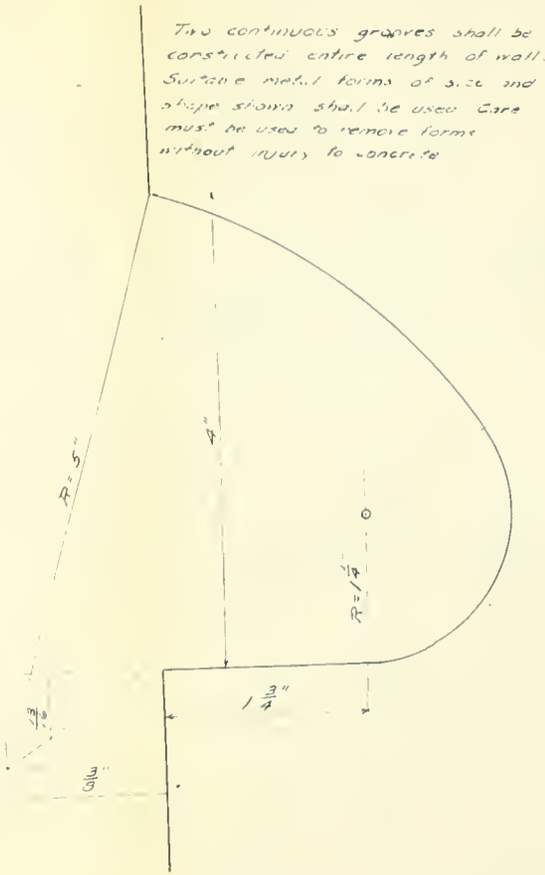
EXPANSION JOINT



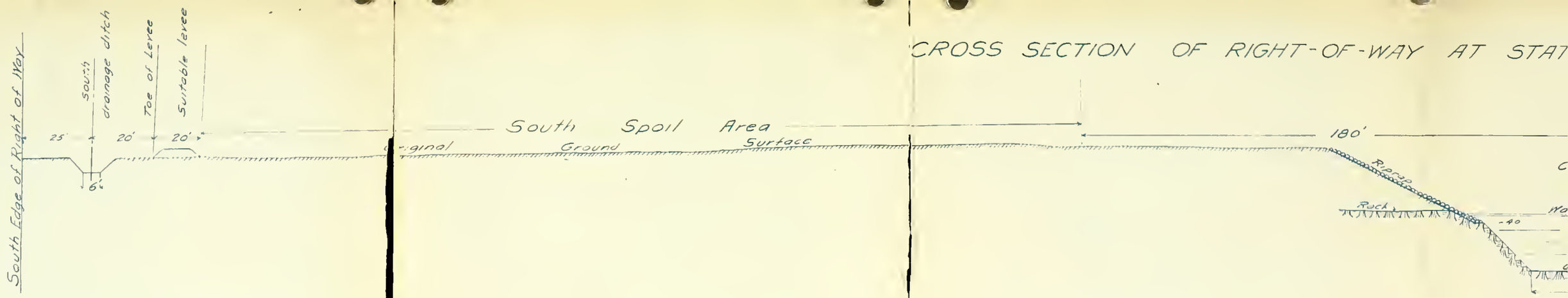
LIFE LADDER



HORIZONTAL GROOVE

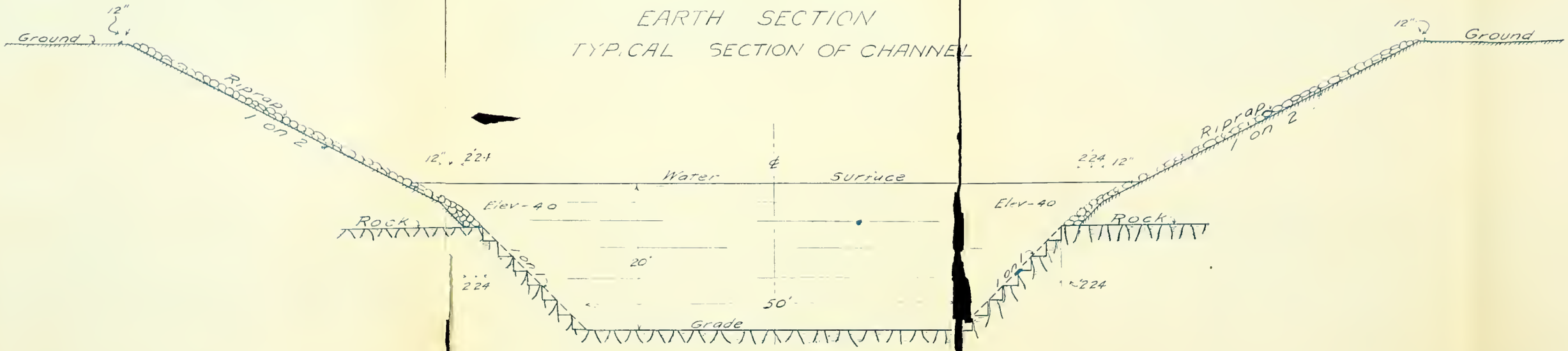

Two continuous grooves shall be constructed entire length of wall. Surface metal forms of size and shape shown shall be used Care must be used to remove forms without injury to concrete
R=5"
4"
R=1/4"
1 3/4"
1/8"
3/4"

CROSS SECTION OF RIGHT-OF-WAY AT STAT



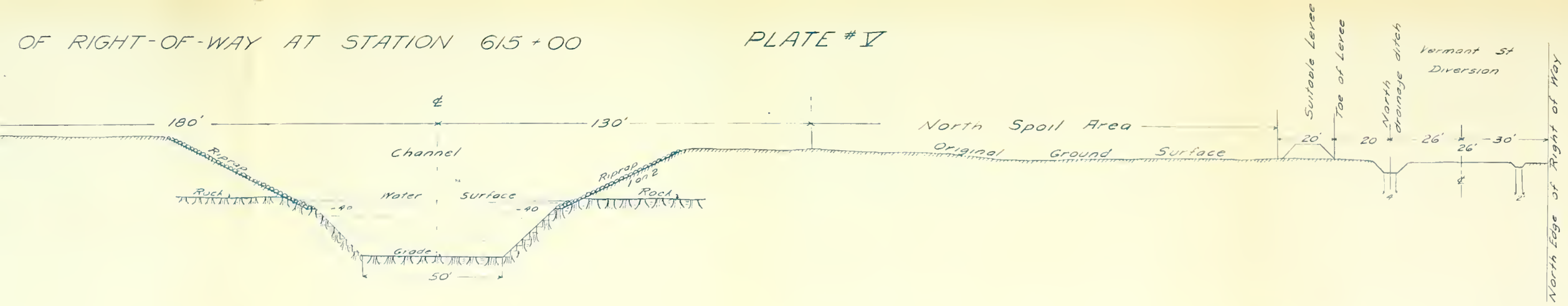
EARTH SECTION

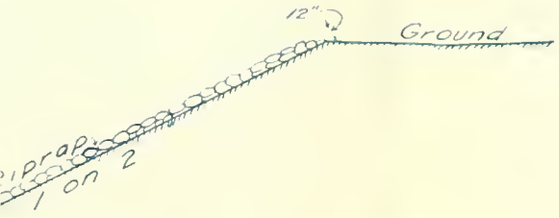
TYPICAL SECTION OF CHANNEL



OF RIGHT-OF-WAY AT STATION 615+00

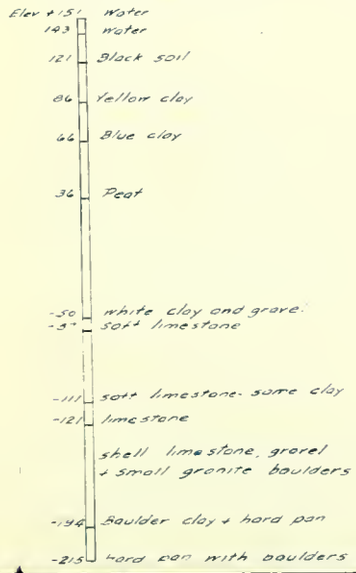
PLATE # V



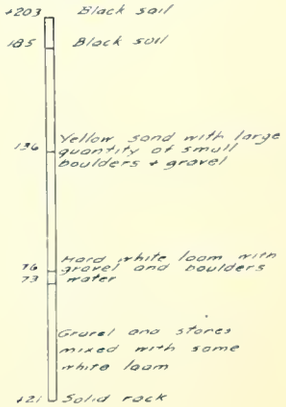


Material encountered Secs # 9, 10, & 12

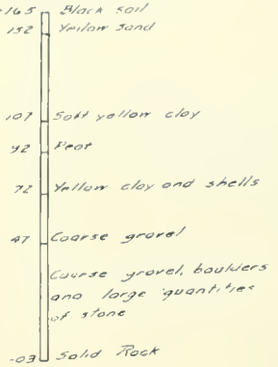
Sec # 9
Boring # 65 at ℄ Sta 551+09 - Diam = 4"



Sec # 10
Test pit # 37 - ℄ Sta 616+70 - 43" D


Elev +203 Black soil
185 Black soil
136 Yellow sand with large quantity of small boulders & gravel
76 Hard white loam with gravel and boulders
73 Water
Gravel and stones mixed with some white loam
121 Solid rock

Sec # 12
Test pit # 24 - Sta 722+00 Diam = 24"


Elev +165 Black soil
152 Yellow sand
107 Soft yellow clay
92 Peat
72 Yellow clay and shells
47 Coarse gravel
Course gravel, boulders and large quantities of stone
-03 Solid Rock

South Edge of Right of Way
South
drainage ditch
Toe of Levee
Suitable levee
25'
20'
20'
6'

12"
Ground
Riprap
1 on 2
12"
Rock

1

2

3

4

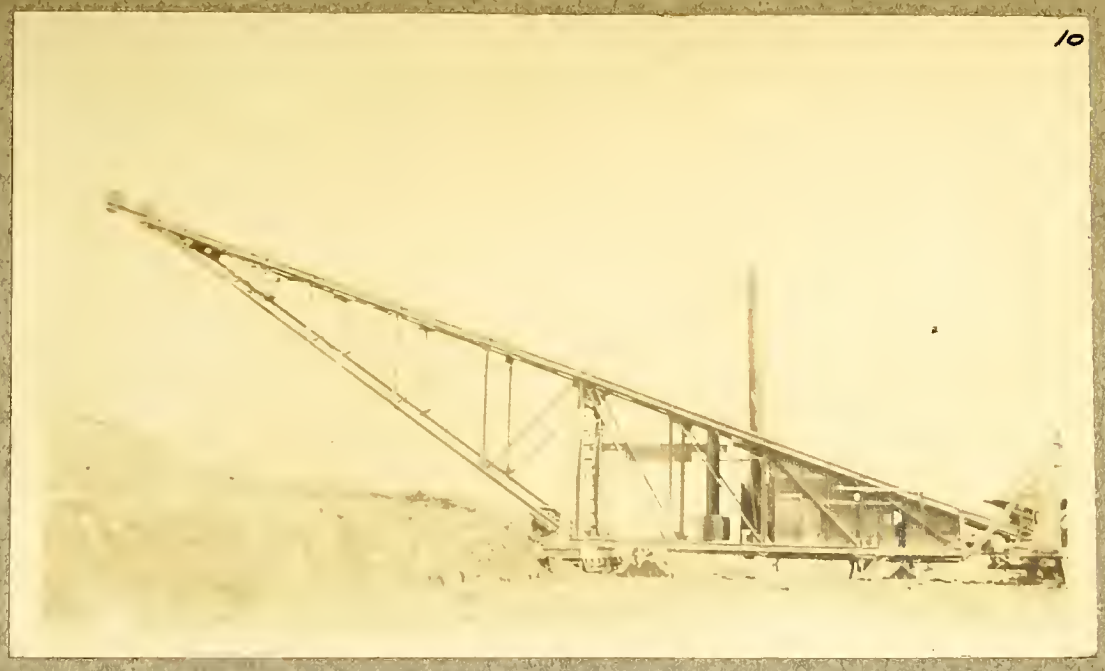
5

6

7

8

9



10

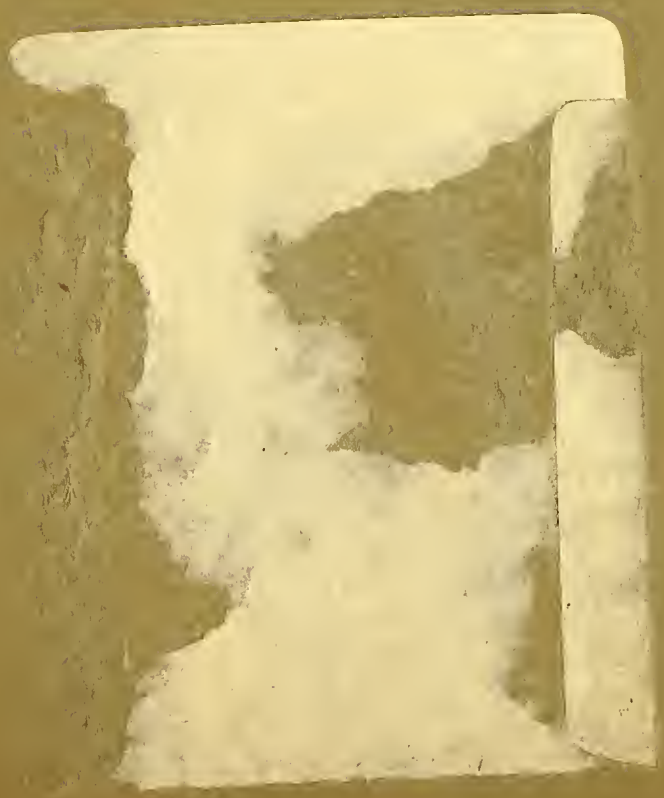
11

12

13

14

15

16

17